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GENERAL ELECTRIC
INSTRUMENTATION
SERVICE
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TEST & ALIGNMENT PROCEDURES

FOR

TYPE 190A Q METER

GENERAL ELECTRIC CO.
Instrumentation & Control
228 W. Florence Ave.
Inglewood, Calif. 90301

BOONTON RADIO COMPANY

Green Pond Road **Rockaway, New Jersey**

U. S. A.

AL SIMPSON (HP Service Mgr)
714-870-1000

New BRC Plant

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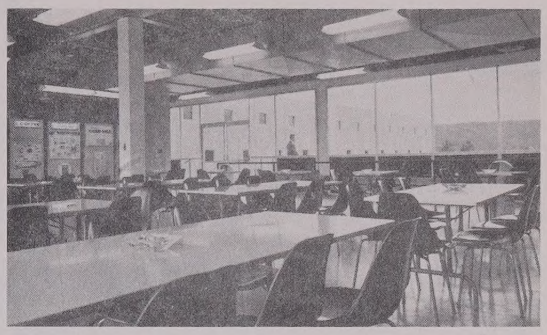

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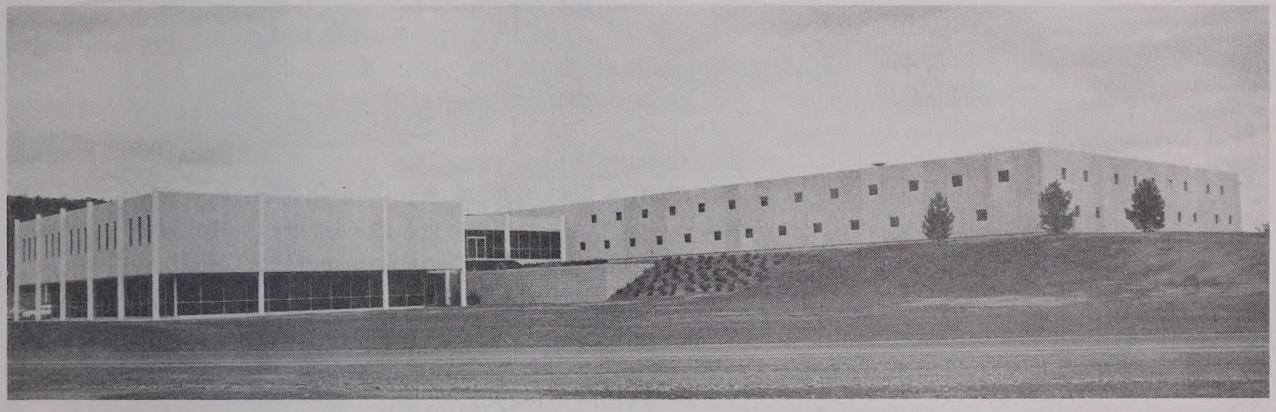

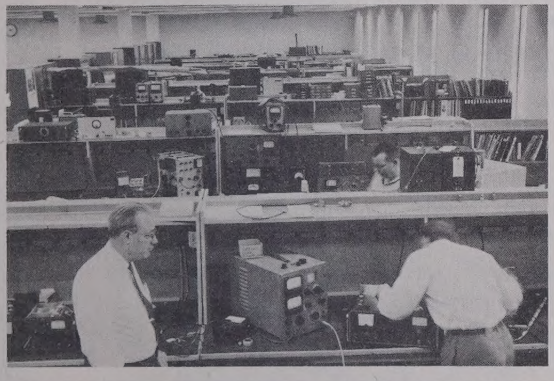

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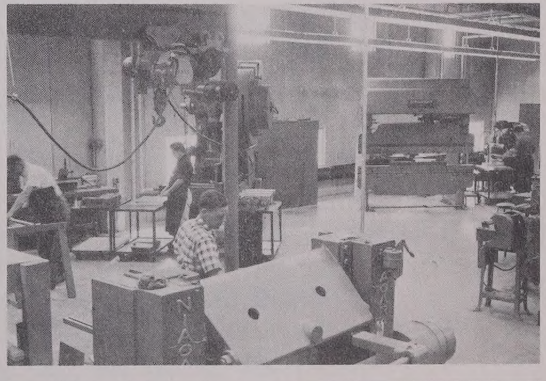

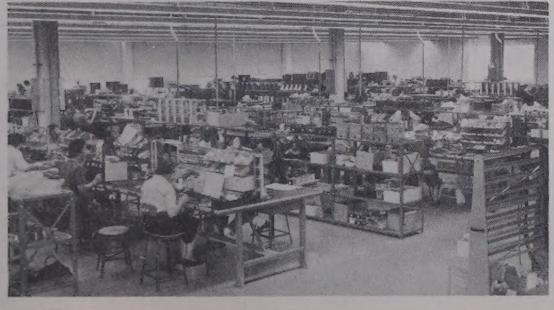

ASSEMBLY

INSPECTION

INDEX TO 190A Q METER

INFORMATION

IN

THE BRC NOTEBOOK

Your attention is invited to the following articles in the BRC Notebook to supplement the information in this manual. Copies of the BRC Notebook are available through your nearest -hp- Sales Office.

Notebook Number	Article
1	The Nature of Q
4	A Versatile Instrument - - The Q Meter
4	Check Your Q Readings by the Delta C Method
7	Calibration of the Internal Resonating Capacitor of the Q Meter
8	Circuit Effects on Q (includes "Correlation of 190A and 260A Q Meters in Overlapping Frequency Ranges")
13	Q Meter Techniques
16	The RX Meter or the Q Meter?

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SECTION I

TECHNICAL DATA

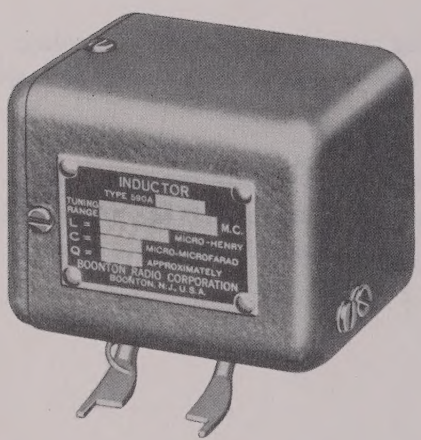
AND

SPECIFICATIONS

The Technical Data Sheet on the following page contains the published "catalog specifications" to which each instrument is guaranteed to operate when in good repair and properly aligned.

Voltages and other test and alignment data given in this manual should not be considered as "specifications" of the instrument, but rather as "typical limits" which will assure operation of the instrument within "catalog specifications".

TYPE 590-A



Inductors Type 590-A are designed specifically for use in the Q Circuit of the Q Meters Type 170-A and 190-A for measuring the radio-frequency characteristics of condensers, resistors, and insulating materials. They have general usefulness as reference coils and may also be used for periodic checks to indicate any considerable change in the performance of the Q Meters.

Each inductor Type 590-A consists of a high Q coil mounted in a shield and is provided with spade lugs for connection to the coil terminals of the Q Meters. The shield is connected to the lugs which connect to the Low Coil terminal in order to minimize any changes in characteristics caused by stray couplings to elements or to ground.

Type	Inductance μh	Capacitance pf	Approximate Resonant Freq. mc.	Approximate Q	Approximate Distributed C pf
590-A1	0.05	95.0 — 7.5	70 — 230	350	1.5
590-A2	0.1	95.0 — 7.5	50 — 160	320	1.7
590-A3	0.25	100 — 7.5	30 — 100	380	2.3
590-A4	0.5	80 — 7.5	25 — 70	360	2.3
590-A5	1.0	60.0 — 7.5	20 — 50	350	2.9
590-A6	2.5	15.0 — 8.0	20 — 30	330	2.9

Price: $17.75 each.

$95.00 for complete set of six.

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Q REFERENCE INDUCTORS

Types 590-A1 and 590-A3 Inductors are available from Boonton with a more precise calibration of the Q as would be indicated on a 190A Q Meter. See page 12 of this manual.

Q METER TYPE 190-A

FSN 6625-669-3273

Frequency Range 20 to 260 MC

Description

The Q Meter was first designed and introduced in 1934 as a means of measuring Q or "Figure of Merit" of coils. Improved models and broadened applications have kept pace with a rapidly growing industry, and the Q Meter is recognized as a flexible general purpose device with a large number of uses.

The 190-A employs a special coupling impedance to introduce voltage across a series-tuned, resonant circuit. This voltage, as well as the reactive voltage developed across the internal Q capacitor, is measured by two high impedance, low input capacitance vacuum tube voltmeters and indicated on a single front panel meter.

The series-tuned circuit includes the coupling impedance, a precision variable capacitor of low loss and low inductance, and binding posts for attachment of an external inductance. Careful design has resulted in a low minimum capacitance in the Q measuring circuit, which permits measurement of coils designed to operate in low capacitance circuits. Internal residual impedance in the Q measuring circuit has been kept to a minimum so that correct measurement of higher values of Q can be made.

Features

As a result of our studies, field information, and suggestions received from our customers, we have incorporated in our present Q Meters those modifications and additions which it was felt would increase the usefulness of the instrument.

1. "Lo Q" Scale. Direct reading expanded scale permits the measurement of Q down to 5.
2. "ΔQ" Scale. Direct reading expanded scale permits the reading of very small changes in Q resulting from the variation of test circuit parameters.

BOONTON RADIO COMPANY

A Division of Hewlett-Packard Company

GREEN POND ROAD
ROCKAWAY, NEW JERSEY 07866

Precision Electronic Instruments since 1934

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3. Regulated Power Supply. The instrument has an internally regulated power supply which assures stability of readings under voltage source variation.

4. The meter scale has a mirror reflector to eliminate error due to parallax.

5. The instrument has been designed to minimize internal residual inductance and resistance.

6. All tubes can be replaced by the customer without returning the instrument to the factory.

Specifications

Radio Frequency Characteristics

RF RANGE:
Total Range: 20 to 260 Mc.
No. Bands: 4
Band Ranges: 20 — 40 Mc. 80 — 160 Mc.
40 — 80 Mc. 160 — 260 Mc.

RF ACCURACY: ±1%

RF CALIBRATION: Increments of approximately 1%.

Q Measurement Characteristics

Q RANGE: Total Range: 5 to 1200
Low Range: 10 to 100
△ Range: 0 to 100

Q ACCURACY: ±7%* 20 to 100 Mc.
±15%* 100 to 260 Mc.

*For circuit Q of 400 read directly on indicating meter.

Q CALIBRATION
Main Scale: Increments of 10 from 50 to 400
Low Scale: Increments of 2 from 10 to 100
△ Scale: Increments of 2 from 0 to 100
XQ Scale: Increments of 0.1 from 0.5 to 1.5
Increments of 0.5 from 1.5 to 3.0

Resonating Capacitor Characteristics

CAPACITOR RANGE: 7.5 to 100 pf

CAPACITOR ACCURACY: ±0.2 pf 7.5 to 20 pf
±0.3 pf 20 to 50 pf
±0.5 pf 50 to 100 pf

CAPACITOR CALIBRATION: 0.1 pf increments.

Accessories

FURNISHED: None

AVAILABLE: Type 590-A Inductors

Tube Complement

1 — OB2
1 — 537-A
1 — 537-B
1 — 538-A
2 — 5718

Physical Characteristics

MOUNTING: Cabinet for bench use.

FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS: Height: 10-1/2" (26.7 cm)
Width: 13-1/8" (33.3 cm)
Depth: 9-1/2" (24.1 cm)

WEIGHT:
Net: 25 lbs. (11.3 kg)
Gross Domestic: 32 lbs. (14.4 kg)
Gross Export: 55 lbs. (24.8 kg)
Legal Export: 30 lbs. (13.5 kg)

Power Requirements

190-A: 90-130 Volts, 60 Cps, 55 Watts
190-AP: 90-130 Volts, 50 Cps., 55 Watts

Price: 190-A: $995.00 190-AP: $995.00

II TESTING OPERATION OF THE 190A Q METER

This section is intended to outline procedures for assuring proper operation of the instrument.

Subsection B gives preliminary checks as an indication of the instruments operation.

Subsection C presents procedures for testing specified accuracies of the Q Meter.

A. Equipment Required

Audio Oscillator (-hp-200CD or equivalent)
Standard Variable Capacitor (GR-1422D or equivalent)
Shielded Inductors (BRC 590-A1 and 590-A3, with "Q Reference Inductor" data; see page 12)
Shielded Inductor (approx 25mh; BRC 103-A42, BRC 518-A5 or equivalent)
Q Meter (BRC 160A or 260A)
500 MC Electronic Counter (-hp-524 and 525C or equivalent) OR
Crystal Calibrator (Measurements III or equivalent)

B. General Operational Checks

(Instrument turned ON and warmed up a couple of minutes)

1. "X" and "Q" Zero-Set Controls

To check operation of the zero controls, proceed as follows:

(a) Turn SET XQ control to minimum (full CCW), and short HI and GND terminal posts together.
(b) Depress XQ Lever switch and adjust "X" zero control for zero meter deflection. Release switch.
(c) Set "Q" zero control for zero meter deflection, then alternately depress and release the LO-Q lever switch while refining the "Q" zero control adjustment. The electrical and mechanical zeros coincide when there is no change in meter deflection as the LO-Q lever switch is actuated.
(d) Remove short circuit from terminal posts.

2. Oscillator and XQ Voltmeter Check

To see that the internal RF oscillator is oscillating and has sufficient RF output over its entire frequency range *, proceed as follows:

(a) Depress XQ lever switch and advance SET XQ control for full scale deflection (XQ=0.5).
(b) Turn MC Dial across entire range of calibrated frequencies; at any frequency, XQ=0.5 should be within range of the SET XQ control.
(c) Repeat above steps for each range of the FREQ RANGE Dial.

* NOTE: Only the frequencies specified by front panel engraving need meet these criterion.

3. Resonating Capacitor

To assure no obvious malfunction, such as shorted plates at some particular dial setting, proceed as follows:

(a) Connect an Audio Oscillator (-hp-200CD or equivalent) between HI and GND terminal posts; advance Amplitude for an up-scale meter deflection.
(b) Rotate MMFD Dial from one stop to the other; a shorted plate would cause the Voltmeter indication to drop to zero.
(c) Remove Audio Oscillator

4. Q-Voltmeter Check

To see that the Voltmeter functions in Q, LO-Q and ΔQ ranges, proceed as follows:

(a) Connect a coil, such as one of the BRC Type 590A series of Shielded inductors, to the COIL terminal posts. Using normal Q-Meter procedures, see that the coil resonates and Q is indicated on the Voltmeter.
(b) With the coil in resonance, change SET XQ control so meter indicator moves slowly from zero to full scale, and return to zero; check meter movement for smooth operation.
(c) Adjust SET XQ control so the meter indicates Q=100 on Q scale. Depress LO-Q lever switch; meter should swing up-scale to approximately Q=100 on LO-Q scale.
(d) Adjust SET XQ control so the Q Voltmeter indicates a Q=250; set ΔQ Balance Dial to 300. Depress XQ lever switch; approximately a mid-scale meter indication should result. Now check smoothness of Coarse and Vernier ΔQ Balance Controls, changing SET XQ control as required to retain on-scale meter deflection.

C. Testing Specified Accuracies

1. RF (frequency) Accuracy

(a) Connect a Crystal Calibrator between LO and GND terminal posts (10 mv available there when XQ=1.0) or connect an Electronic Counter capable of measuring to 260 MC, to the junction of R110 (100Ω) and the plate pin of XQ diode, V102 (1.0 Volt available there when XQ=1.0).

NOTE: Frequency accuracy measurement should be made with XQ=1, since there is a slight shift of frequency at other settings of the SET XQ control.

(b) Check frequency at convenient increments across each frequency range. Specification: ± 1% of dial calibration.

NOTE: The "calibrated range" of the oscillator is defined by the engraving adjacent to the front-panel MC Dial. Calibration marks on dial beyond this range need not be within ± 1% for the instrument to be within specifications.

2. Resonating Capacitor Accuracy

The Resonating Capacitor, C108, is tested by comparing its absolute capacitance with changes in capacitance of a Standard Variable Capacitor of greater accuracy. This is done by establishing a resonance condition, then substituting the capacitance of the 190A Resonating Capacitor, in incremental changes, for that of the Standard.

The following procedure is commonly referred to as the "Two Q-Meter Method" of measuring capacitance. One of the two Q Meters contains the capacitor being tested, the other serves as a resonance indicator. In the following test, "190A" is the Q-Meter under test, and the "260A" is the indicating Q-Meter. A BRC Type 160A may be substituted for the 260A indicating Q-Meter.

A total change in capacitance of 92.5 pf is to be measured (7.5 to 100 pf) to test the specified accuracy of the 190A. However, when using the following procedure for recalibration, accurate calibration from 7.0 to 105 pf should be assured, making the total change 98 pf.

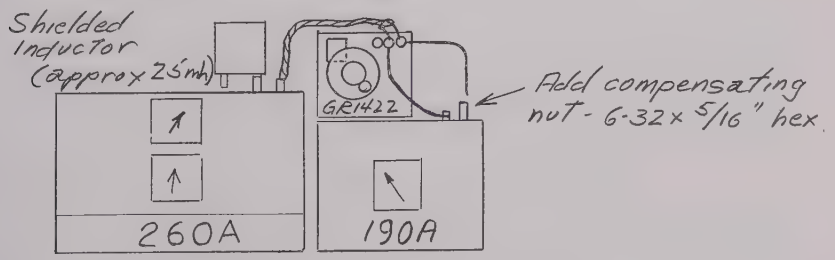
The 190A cabinet need not be opened to test its capacitance accuracy; opening is required only if the need for repair and/or recalibration is evident.

NOTE: The 190A AC power must be OFF during capacitance calibration so that the Q-Voltmeter diode, V103, will not load the measuring circuit excessively (decreased resolution would result).

Since the inter-electrode capacitance of V103 is greater with its filaments heated, this change must be compensated for by adding additional capacitance. Add a 6-32 x 5/16" brass nickel plate hex nut to one of the HI terminal posts on the 190A.

(a) Equipment Connections

(1) Position the equipment as shown:



(2) Turn 260A ON to warm up; leave 190A OFF.

(3) Connect a short piece of coaxial cable between 260A CAP terminals and low * section of the Standard Variable Capacitor. Shield goes to ground terminals.

(4) Connect a piece of large bare tinned copper conductor (#14) from ground terminal of the Standard to the GND terminal of the 190A.

(5) Connect another piece of the conductor to the insulated terminal* of the Standard Capacitor. Position the free end 3/8" to 1/2" from either HI terminal of the 190A. The tip of this self suspended lead must be straight, without hooks or loops, and must point down to the HI terminal.

* The LOW section of the GR-1422D is used to fulfill the required capacitance accuracy.

(6) Place a shielded Coil, approximately 25 mh, on the COIL terminals of the 260A. The BRC 103-A42 Inductor or the BRC 518-A5 Q Standard may be used. If a coil of higher Q is available (500 or so) higher resolution of the capacitance accuracy can be obtained.

(b) Preliminary Adjustments

(1) Set equipment controls as follows:

Standard Variable Capacitor - - near maximum calibrated capacitance	(110.00 pf on GR1422D)
260A -	MMFD Dial-approx 100 Oscillator - approx 50-70 KC
190A -	MMFD Dial approx 10.0

(2) Obtain a resonance indication on the 260A using the oscillator frequency controls.

(3) Adjust the "XQ" controls on the 260A for a peak meter indication of precisely full-scale on the LO-Q scale. (The increased meter sensitivity on the LO-Q scale will provide better resolution of peak resonance). The vernier MMFD Dial on the 260A may be used to obtain the precise resonance peak.

(c) Capacitance Measurement

Technique: When setting any of the capacitance dials, the effect of backlash should be minimized by approaching all capacitance settings in the direction of increasing capacitance. Never "overshoot" and then "rock-in" to final setting unless it has been determined first that backlash between dial and capacitor is negligible.

(1) Touch the suspended conductor to the HI terminal of the 190A, changing its relative position as little as possible.

(2) Decrease the Standard exactly * 10.00 pf, then re-resonate with the 190A MMFD Dial. Resonance should occur at 10.00 pf, ± 2 vernier dial divisions.

(3) Check backlash of the 190A MMFD Dial by approaching the exact peak of resonance in both directions of the dial. Repeat several times and take average of reading in each direction. If there is more than one vernier division of backlash, the cause should be corrected before proceeding.

(4) Increase the Standard exactly 2.5 pf, then re-resonate with the 190A MMFD Dial. Resonance should occur at 7.5 ± 2 vernier dial divisions on the RED Scale.

(5) Reset the Standard to the position for resonance at MMFD = 10 on the 190A, then decrease the Standard in exact 10.00 pf increments, re-resonating each time with the 190A MMFD Dial. Resonance should occur within the following limits:

190A MMFD Dial	Tolerance
7.5 - 20	± 2 vernier divisions
20 - 50	± 3 vernier divisions
50 - 100	± 5 vernier divisions

* Apply scale correction factors to dial settings of Standard Variable Capacitor to obtain required capacitance accuracy.

(6) If your Standard Variable Capacitor has sufficient range to measure to 100 on the 190A MMFD Dial, this step may be omitted.

Upon reaching last setting before the minimum calibrated capacitance of the Standard (35.00 pf on the GR-1422D), proceed as follows:

Establish an exact peak resonance indication using the 190A MMFD Dial.

Increase Standard Capacitance to maximum calibrated capacitance (not greater than a 70 pf increase, however).

Decrease 260A MMFD Dial to re-establish the exact peak resonance indication; use 260A MMFD vernier dial to peak. (A 70 pf decrease is possible -100 pf down to 30 pf).

Continue measurements on 190A Dial as in step 5.

3. Circuit Q Accuracy

The specified "Circuit Q" accuracy relates the Q-Voltmeter reading on the 190A ("Indicated Q") to the actual Q of the entire resonant circuit. The resonant circuit includes the internal measuring circuitry of the Q Meter, as well as the external coil and other components measured.

Circuit Q (Qckt) and Indicated Q (Qi) are defined as follows:

$$Qckt = \frac{Ec}{Ei} = \frac{\text{resonant rise of voltage across resonating capacitor}}{\text{voltage injected into the series resonant circuit}}$$

$$Qi = \frac{Eqvm}{Exqvm} = \frac{\text{voltage indicated on Q Voltmeter}}{\text{voltage indicated on XQ Voltmeter}}$$

Therefore, Qi and Qckt may be made the same (or within the specified tolerance) by precisely calibrating the two voltmeter circuits to properly indicate the voltages that define Qckt. (Note that XQ Voltmeter Calibration must be supplemented by setting of the "Sliding Lug" to adjust the actual voltage injected at the LO post with respect to the XQ Voltmeter indication).

The final requirement after voltmeter calibration is to assure that the effect of internal Q Meter losses on Q indications are typical as compared with other Q Meters of the same type. The internal measuring circuit losses vary slightly from instrument to instrument and will change substantially should a failure occur within the Q Meter. By measuring inductors of known Q it can be determined if there are excessive losses within a particular Q Meter.

To assure that each instrument shipped from the factory includes only "typical" losses, each is used to measure the Q of a number of BRC Type 590A Inductors on which data has been accumulated from numerous measurements.

For Field Q Calibration by the customer, the "Instruction Manual for the Model 190A Q Meter" (paragraph 3.3, page 4) recommends:

"When the Model 190A is first received and put into operation, it is suggested that careful measurements be made, using a set of BRC Type 590A Inductors, and that data be recorded and filed. At least one measurement should be made near each end of each frequency band, with the exception of 20 and 260 MC. These recommended measurements provide a set of standard data for each individual Q Meter, which will be available for reference and comparison should it ever become necessary to perform calibration or other maintenance work on the equipment."

If the recommended Inductors and data are available, the Q measurements should be repeated, then the cause of any discrepancies from original data should be corrected.

Q-REFERENCE INDUCTORS

If the recommended Inductors and/or data are not available, BRC Type 590-A1 and 590-A3 Inductors with Q Calibration Data may be obtained from BRC. Also, your own BRC 590-A1 and 590-A3 Inductors may be returned to BRC where their Q characteristics will be compared with the factory "Reference inductors", and appropriate data returned with them for your use in assuring "typical" Q Measurements on your 190A.

It must be understood that the 590A Inductors with this more precise Q Calibration are "Reference Inductors" only; they cannot be considered "Standards", as are the Types 513A and 518A Q Standards used with Types 160A and 260A Q Meters. Q Standards for use in the frequency range of the BRC 190A are not available.

Q Reference Inductors are available from BRC as follows:

BRC Inductor Type	"Typical" Q Data Available at	Tolerance for Q Readings On BRC 190A
	220 MC	± 20%
590-A1	120 MC	± 20%
	70 MC	± 15%
	100 MC	± 15%
590-A3	55 MC	± 15%
	33 MC	± 15%

A properly operating 190A Q Meter should indicate Q within the tolerances shown above. The tolerance includes the Catalog Specification of Circuit Q for the 190A, plus a tolerance for the "Reference Inductor".

With "Reference Inductors", final calibration can be made directly by measuring Q and comparing the values with the "Typical" Q Readings. The necessary adjustments or repairs can then be made to return the instrument to original operation.

To obtain repeatable Q indications when using Q Reference Inductors, make certain that the Binding Post Nuts are securely tightened. If corroded or badly worn, the nuts (#301070-1) should be replaced.

Low Q indications with high Resonating Capacitance are most likely caused by contact resistances, or Voltmeter Calibration.

Low Q indications with low Resonating Capacitance are most likely caused by excessive loading by the Q Voltmeter diode, V103.

High Q indications or low Q indications at all C settings and/or frequencies are most likely caused by Voltmeter Calibration errors, or by incorrect adjustment of the "Sliding Lug" within the "Transmission Line" Assembly.

Without "Q Reference Inductors", preliminary calibration of 190A Q Meter should be performed as described in Section III-F-3 of this manual (Q Measurement by Delta-C Method).

III. 190A TEST AND ALIGNMENT PROCEDURE

A. Equipment Required

RMS responding Voltmeter, 0-10 volts (-hp-3400A VTVM or equivalent)
AC VTVM, ± 3% at 20 MC (-hp-410B or equivalent)
DC Voltmeter, 1000Ω/V or greater
AC VTVM, ± 1% at 100 KC (-hp-400H or equivalent)
Q Meter, BRC 160A or 260A
Audio Oscillator (-hp-200CD or equivalent)
Standard Variable Capacitor (GR-1422D or equivalent)
Shielded Inductors (BRC 590-A1 and 590-A3, with "Q Reference" data, see page 12)
Shielded Inductor (approximately 25 mh; BRC 103-A42, BRC 518-A5 or equivalent)
500 MC Electronic Counter (-hp-524 and 525C or equivalent)

OR

Crystal Calibrator (Measurements III or equivalent)

B. Power Supply Check

1. Depress XQ lever switch and adjust SET XQ control for 0.5 on the XQ scale.

2. With a DC Voltmeter measure "HI DC" voltage at C302 (electrolytic) on power supply chassis:

   "HI DC" = 190-210 VDC

3. With a DC Voltmeter measure "Reg. DC" at the wire jumper between pins 1 and 6 of V200 (538A, 12AT7):

   "Reg DC" = 105-108 VDC

4. With an RMS responding Voltmeter measure the filament voltage at pin 9 of V200 (538A, 12AT7):

   "Filament Volts" = 6.0 - 6.6 VRMS ⋕

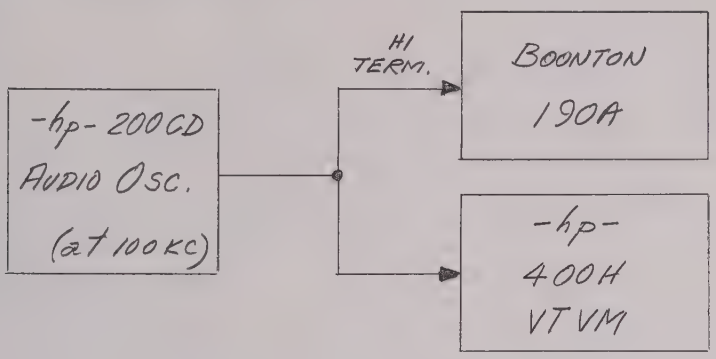
5. With an RMS responding Voltmeter measure the Diode Filament Voltage at V102 and/or V103 diodes (ungrounded pin of the group of 3 tube pins):

   Diode Filament Volts 3.3 - 3.8 VRMS ⋕

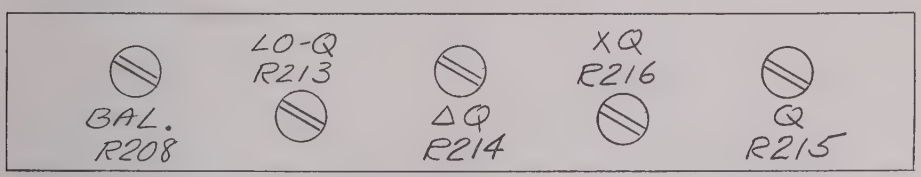
⋕ Filament Voltage waveform is distorted by voltage stabilizer, VR300, requiring RMS measurement to determine true heating value. If measured on a VOM such as a Simpson 260, indications will typically be .5 to .7 volts higher than values given above.

C. Voltmeter Calibration and Adjustment

1. Equipment Connections



2. Location of Voltmeter Adjustments (as seen when viewing rear of upright 190A)



3. DC Amplifier Balance (R208)

The DC Amplifier balance potentiometer R208 should be readjusted whenever V200(12AT7, BRC 538A) is changed. If adjustment is beyond the range of R208, V200 tube sections are excessively unbalanced; try another 12AT7 (pre-selected tubes for V200 are available as BRC Part #538A).

(a) With instrument OFF, adjust mechanical zero of meter movement.

(b) Turn instrument ON and allow to warm up at least 10-15 minutes.

(c) Locate resistors R206 (470KΩ) and R210 (10 KΩ) on resistor board adjacent to shield of V200.

(d) Temporarily connect the two resistors at the ends nearest the tube, V200; this shorts the two grids, pins 2 and 7, together.

(e) Adjust R208 for zero meter deflection.

(f) Remove the short from between R206 and R210.

4. Q-Voltmeter Calibration (R215)

The Q-Voltmeter is a 4 volt full-scale VTVM and is calibrated and tracked by comparison with an -hp- 400H VTVM (or equivalent meter accurate to 1% at a frequency of 100 KC).

(a) Connect equipment as shown in paragraph C, 1.

(b) Momentarily disconnect cable from Audio Oscillator, short leads together and establish proper zero settings on both meters.

(c) Reconnect Audio Oscillator and adjust output voltage for successive indication of 4, 3, 2, and 1 volt as indicated on the -hp- 400H.

Typical tolerances are as follows:

-hp- 400H	190A Q-VM
4.0 V	393-407
3.0 V	293-307
2.0 V	193-207
1.0 V	93-107

(d) Adjust R215 for best overall accuracy within the above tolerances.

5. LO-Q Voltmeter Calibration (R213)

(a) With connections and control settings as described above, adjust Audio Oscillator output for exactly 1.0 Volt on -hp-400H (change -hp- 400H range as appropriate for up-scale indication; recheck zero settings).

(b) Depress LO-Q lever switch, meter should indicate near 100 on LO-Q scale.

(c) Adjust Audio Oscillator output for successive indications of 1.0, 0.8, 0.6, 0.4, and 0.2 Volts on the -hp- 400H.

Typical tolerances are as follows:

-hp- 400H	190A LO-Q-VM	
1.0V	98 - 102	*_____
.8V	78 - 82	
.6V	58 - 62	
.5V	48 - 52	*_____
.4V	38 - 42	
.2V	18 - 22	

(d) Adjust R213 for best overall accuracy within the above tolerances.

* NOTE: Record exact LO-Q-VM indications above for use in a later procedure (measuring Q by the Delta C Method on page 22).

6. ΔQ Voltmeter Calibration (R214)

(a) With connections as described above adjust Audio Oscillator output for 400H Voltmeter indication of 2.5V.

(b) Depress ΔQ lever switch and adjust ΔQ BALANCE controls for zero deflection (ΔQ = 100 on red scale).

(c) Release ΔQ lever switch and increase Audio Oscillator output for 3.5 V on 400H.

(d) Again depress ΔQ lever switch and adjust R214 for full-scale deflection (ΔQ=0 on red scale).

(e) Repeat above steps to assure that the 1.0 Volt change between 2.5 V causes exactly 100 Q change on the ΔQ scale.

7. "XQ" Voltmeter Calibration (R216)

Should the XQ diode V102 be replaced, R216 must be readjusted to maintain maximum calibration accuracy.

(a) Equipment Connections

Connect the AC probe of the VTVM to the junction of L104, R110 (100Ω), and the plate pin of V102 (Tack - soldering a 3" to 4" insulated conductor to the probe tips as an "extension" will facilitate connection within the 190A).

(b) Set 190A FREQ RANGE Switch to 20-40 MC; MC Dial to approximately 20 MC.

(c) Turn SET XQ Control to minimum (full CCW); adjust "X" zero control.

(d) Set VTVM to range for 0-1 Volt measurement and carefully check VTVM zero setting.

(e) Advance SET XQ Control for exactly 1.0 Volt as indicated on external VTVM.

(f) Adjust R216 for an indication of "X1" on 190A Meter (XQ lever switch depressed).

(g) Change the SET XQ Control for the XQ meter indications below; typical VTVM tolerances are given as a test of circuit linearity.

XQ Setting	Typical Tolerance of VTVM Readings
3.0	0.307 - 0.359 V
1.0	1.00 V (reference)
0.5	1.90 V - 2.10 V

D. Oscillator Alignment

1. Mechanical Checks before alignment
(Front Panel Assembly separated from cabinet; power removed from instrument).

(a) Remove cover from oscillator casting. Note that cover is in two pieces; remove them as one unit by removing only the six screws that secure it to the casting (four on plate: two on side).

(b) Observe position of pick-up loop (L104). Turn FREQ RANGE Control thru all bands, seeing that none of the coils hit the pick-up loop.

(c) See that band-switching mechanism works smoothly. The two beveled gears in the drive mechanism should be fully meshed (not off-set), however, there should be a slight space between them so they do not bind together.

(d) Check position of Oscillator Turret. When the detent cam is properly positioned on the turret shaft, each oscillator coil should detent on center-line of pick-up loop (L104).

(e) With an Ohmmeter, check action of the microswitch, S101 (mounted on detent cam follower arm). Continuity should break as soon as the band-switching mechanism starts out of detent.

(f) Clean contacts on turret and wipe with a piece of crocus cloth to assure good contact. Clean both the edges and flats of each contact on the rotor assembly.

(g) Check wiring of the two tubes; leads should be short and direct (as illustrated in Fig. I V-4, page 23, of the Instruction Manual for Model 190A Q Meter).

(h) Check plate spacing of variable air capacitors. To see the plate spacing, the oscillator assembly must be removed from the panel. Therefore, plate spacing need be observed only when there is reason to suspect that there has been damage, or the screwdriver spacing adjustment (adjacent to the glass capacitor, C103) has been disturbed.

(i) The cores in the 20-40 MC, 40-80 MC and 80-160 MC ranges are held in place with coil-dope. If adjustment is required, loosen with thinner or butyl acetate to avoid breaking the core or coil form.

2. Oscillator Preliminary Adjustments

(a) Turn instrument ON and allow to warm up for at least five minutes.

(b) Depress the XQ lever switch and advance the SET XQ Control to XQ=.5 (full scale).

(c) Rotate MC Dial thru band, and FREQ RANGE switch to each range, see that the oscillator output is sufficient to allow re-setting of SET XQ Control to XQ=.5 at all calibrated frequencies.

NOTE: If oscillator output is low try moving pick-up loop, L104, closer to turret coils, or change oscillator tubes. Watch for sudden variations in RF output which would be an indication of parasitic oscillations.

(d) Connect a Crystal Calibrator to the LO terminal post (10 MV available at XQ=1) or connect an Electronic Counter to the junctions of R110 and the plate pin of V102 (1 Volt available at XQ=1). All frequency accuracies must be tested and adjusted at XQ=1; oscillator frequency varies slightly at other XQ settings.

(e) REMINDER: The oscillator frequency will be slightly different when the cover is removed from the oscillator assembly. When aligning frequency accuracy this must be taken into consideration. The affect will be greatest on the higher frequency bands.

3. Oscillator Tracking and Alignment

CAUTION: B+ Voltage exists between rotor and stator of the variable air capacitors and on RF coils. Use an insulated tool to make adjustments or move FREQ RANGE Switch out of detent before making adjustments (microswitch removes B+). IMPORTANT: To avoid contact with B+ turn instrument OFF or place FREQ RANGE switch out of detent when removing or replacing cover of oscillator assembly.

(a) 40-80 MC Range Tracking

The accuracy with which this range is tracked, by bending the serrated plates of C104A and C104B, will determine the overall frequency dial accuracy after complete alignment of all bands. Care taken in adjustment here will pay off later.

(1) Set FREQ RANGE switch to 40-80 MC, MC Dial to 80 MC.

(2) With the cover removed from the oscillator the frequency will be slightly different than 80 MC; therefore, adjust the trimmer capacitor C103, so the output frequency corresponds to the Dial with cover in place.

(3) Remove cover and note effect on output frequency.

(4) Starting at 80 MC bend the serrated rotor plates for the best possible frequency accuracy across the band. (Consider frequency offset due to cover being removed).

CAUTION: Rotor to stator spacing is extremely close; therefore, take care not to short plates together. To test for shorted plates, depress XQ lever switch, and rotate MC Dial from one end of dial travel to the other. If plates short, meter indication will drop suddenly.

(5) Replace oscillator cover and check overall frequency; repeat as required for best possible frequency accuracy.

NOTE: In all probability, readjustment of the core of the 40-80 MC coil will not be required unless repairs were made to that coil.

(b) 20-40 MC Range Alignment

(1) As with all other ranges, the frequency change when the cover is replaced must be considered.

(2) Loosen coil-dope, then adjust core for best overall frequency accuracy within ± 1% specification.

NOTE: If slightly out at one point on dial, a slight readjustment of the serrated rotor plates may help; its effect on all other ranges must be considered, however.

(c) 40-80 MC Range Alignment

Done first in step (a); do not repeat here in sequence.

(d) 80-160 MC Range Alignment

(1) Again consider the effect on frequency accuracy due to replacing cover.

(2) Loosen coil-dope, then adjust core for best over-all frequency. (See NOTE under (b)-(2), above.

(e) 160-260 MC Range Alignment

(1) Replacing oscillator cover will have the greatest effect on the frequency accuracy of this range; consider its effect when making adjustments.

(2) Frequency accuracy adjustment is made by positioning the circular loop with respect to the arced loop. Move the circular loop further away from, or closer to the other one as required to obtain best overall frequency accuracy.

4. Final Checks and Reassembly

(a) Check that all coils on turret clear the pick-up loop as turret is rotated thru all positions.

(b) If any of the cores have been loosened for adjustment re-apply coil-dope.

(c) Replace cover on oscillator casting; secure all screws.

(d) Recheck frequency accuracy to assure that frequency changes due to replacing oscillator cover have been properly compensated for during alignment.

E. Calibration of Resonating Capacitor, C108

Field repair and calibration of the Internal Resonating Capacitor may be made if facilities are available for the precision measurement of capacitance. Measurement techniques and equipment required are given on pages 7 and 9.

1. Preliminary Checks

(a) Examine capacitor for foreign matter, specs of dirt, etc. Such matters tend to lower the Q of the capacitor by introducing a spurious resistance across it.

(b) Check for smooth operation of gear mechanism and positive action of the stop mechanism.

(c) Check position of rotor vs. dial setting. (Look thru plastic binding post shield on top of instrument). Rotor should be completely out of mesh at 7.5 pf and slightly in mesh at 10.0 pf.

(d) Make certain rotors are centered in stators. Check plate spacing visually (observe from under-side of assembly). Run out rotor plates to notice any wobble.

(e) Check take-up of spring loaded anti-backlash gears. Improper loading or stiffness will cause backlash.

(f) To provide access to the serrated rotor plates for adjustment, carefully remove coil-dope from the two holes in the plastic binding post shield (near each HI terminal). Replace Binding Post Shield (BRC #300851), if necessary.

(g) A safety pin makes an excellent tool for positioning plates thru these holes; straighten it out and use the point.

2. Backlash

If upon initial measurements of capacitance more than one vernier dial division of backlash is evident, it should be minimized before proceeding with calibration.

The primary causes are:

(a) Malfunction of anti-backlash split gears

(b) Improper tension on shaft by end-play adjustment

(c) Excessively worn parts

(d) Broken ceramic stator mount

3. Calibration

(a) Follow measurement techniques of Section II-C-2, page 9.

(b) If out of calibration between 7.5 and 10.0 pf, it will be necessary to optimize accuracy over this portion of the scale.

This RED Scale is hand calibrated upon manufacture and original calibration, but can almost always be brought to within the ± 2 vernier dial division specification by one or more of the following techniques:

(1) Repositioning fiducial on cabinet (2 front panel screws)
(2) Slipping vernier dial on shaft (allen set screws on hub)
(3) Repositioning and shimming of stator mount with respect to rotor for desired characteristics as rotor approaches and meshs with stator.

(c) Starting of the 10 pf point, position the two outer serrated rotor plates to adjust capacitance to within specified dial accuracy over the range of 10 to 105 pf.

F. Adjustment of Indicated Q (Qi)

Adjustment of the "Sliding Lug", as described below, will raise or lower the actual voltage injected into the Q measuring circuit. Therefore, this adjustment should be made only if all Q readings are high or all low as determined by measurements made with Q-Reference Inductors or from Q Measurement by the Delta-C Method. Of course, Voltmeter calibration (Q and XQ) must be assured correct, first.

1. The "Sliding Lug" Adjustment

The assembly containing L105 and L106 is referred to as the "Transmission Line". Adjustment of the voltage attenuation ratio is made by positioning of the "Sliding Lug" within the Transmission Line; it is connected internally to the 3/16" hex-nut visible on the plate that extends between the bracket supporting the XQ diode (V102) and the Q-Capacitor casting. A slotted hole allows for positioning.

The 3/16" hex-nut is factory sealed after adjustment of the 100:1 voltage attenuation ratio of the line. Should field readjustments be required extreme care must be taken to soften the sealant before attempting to loosen the nut or slide it along the slotted opening beneath it. Twisting off or bending of the 2-56 threaded stud will result in considerable extra repair work.

Various sealants have been used since original manufacture of the 190A. Buytl acetate has been found to be the most effective solvent.

2. Determining if "Sliding Lug" Readjustment is Required

After precise Q-Voltmeter calibration, measurement of Q by the Delta-C method should be made (see procedure on page 23). That value (Qc) may then be compared with the Q reading of the 190A (Qi). Qc will typically be within ± 5% of Qi on a normally operating 190A. Should a difference exist, one or two adjustments may be made:

(a) For minor differences (within ±5%) adjust the SET XQ Control so the 190A Q reading (Qi) is the same as the calculated value (Qc). R216 (XQ meter calibration adjustment) is then slightly readjusted so the XQ meter indicates "1".

This procedure has the advantage of not having to loosen the factory sealed 2-56 threaded stud on the "Sliding Lug". A voltage slightly different from 1.0 Volt may appear at R110; small differences will have no adverse effect on instrument operation, however.

(b) For major differences (greater than ± 5%) the sealant on the 3/16" nut must be softened, then the nut can be loosened with a 3/16" Spin-Tite type wrench. After establishing 1.0 volt for XQ=1 at R110, the "Sliding Lug" can be positioned for proper Q readings.

3. Determining Qc by Delta-C Method * (for Qi adjustment of the 190A Q Meter).

The Q of the coil measured in this procedure must be low enough to obtain a reliable ΔC measurement, yet high enough to allow the use of simplified calculations. A Qi between 100 and 130 meets this criterion.

The coil measured must be shielded, otherwise its stray capacitance contributes to the resonating capacitance (Cr), introducing additional error to the calculation of Qc.

When using a BRC Type 590A-4 Inductor, the Q circuit must be shunted with an appropriate resistor to lower its Qi to the 100 to 130 range. Usually a carbon composition resistor of 10 KΩ to 15 KΩ will properly load the circuit.

* Refer to the BRC Notebook #4, page 7, for further information on Delta-C Method.

Procedure for measuring Qc by Delta-C Method

(1) Connect a BRC Type 590-A4 Inductor (0.5μh shielded) across the COIL terminals.

(2) Set MMFD Dial to exactly 80.00 pf ** (Cr) then tune MC Dial for resonance indication (about 24-26 MC).

(3) Connect the "loading" resistor across the CAP terminals of the 190A.

(4) Re-resonate using the MMFD Dial on the 190A.

(5) Observe Q indication. If below 100 or above 130, change value of "loading" resistor, then repeat steps (3), (4), and (5).

(6) Depress LO-Q lever switch and adjust SET XQ Control for Q=100 on LO-Q scale. (Use scale indication recorded during LO-Q Voltmeter Calibration, page 16).

(7) Increase MMFD Dial setting ** to obtain reading of Q=50 on LO-Q scale; record MMFD Dial reading as C_1 (again use corrected meter scale indication from page 16).

(8) Decrease MMFD Dial setting ** to obtain corrected reading of Q=50 on other side of resonance response; record MMFD Dial reading as C_2. Observe that peak is at exactly the corrected value for Q=100; if not, repeat steps (6), (7) and (8).

(9) Compute the difference between C_1 and C_2; this is the ΔC.

(10) Refer to Graph #1, page 24 to find "Calculated Q".

(11) Repeat steps (6) thru (10) several times and average the results to obtain Qc.

4. Adjustment of the "Sliding Lug" for Qi≈Qc

(a) Using normal Q-Meter Procedures, obtain a Q reading of the "loaded" Q circuit. (Qi = 100 to 130, as above).

(b) Compare this indication (Qi) with the Q calculated above (Qc); Qc will typically be within ± 5% of Qi.

(c) To increase Qi, loosen the 3/16" hex nut on the "Sliding Lug" and move it toward the Oscillator Assembly.

to decrease Qi, move the "Sliding Lug" toward the Q-Capacitor Assembly.

CAUTION: The 3/16" hex-nut is factory sealed with glyptol or other similar sealant after initial adjustment. CARE must be taken to soften the sealant before attempting to loosen the hex-nut. Excess torque will twist or break the 2-56 stud on the "Sliding Lug".

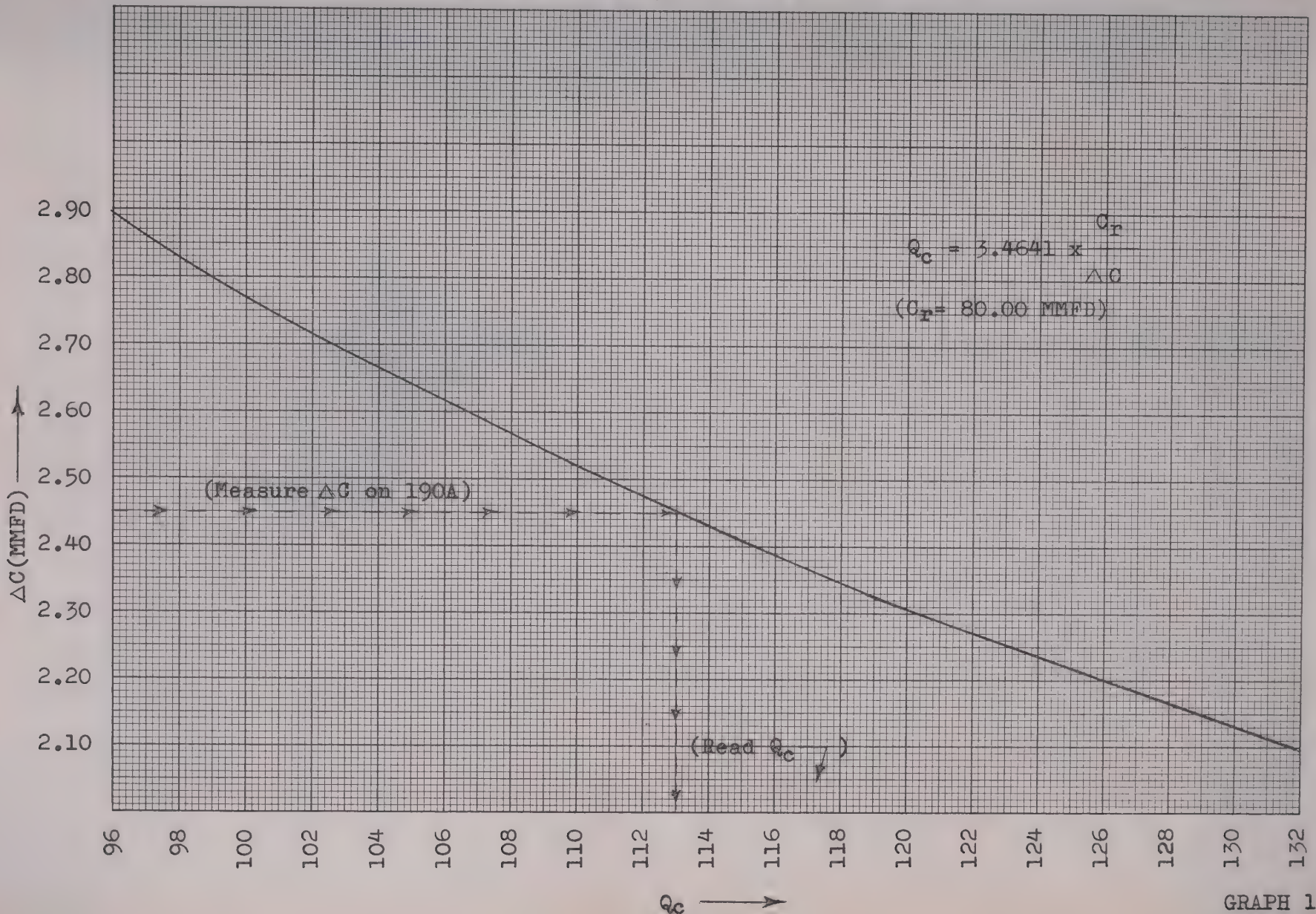
(d) After adjustment tighten hex-nut carefully and re-seal with glyptol or coil-dope.

** To eliminate any error due to backlash, always approach final C setting in direction of increasing capacitance; never "overshoot" setting, then "rock-in".

Graph for Conversion of

$\triangle C$ to Q_c

When Measuring Q_c by the Delta C Method



GRAPH 1

V102 now a hot (cathode) diode
HP - #1901-0518

V103
P
Cathode

FREQ. RANGE TURRET

V-100 5718
C-100 .001
R-100 22K
C-111 2 uuf
R-101 22 K
C-112 2 uuf
V-101 5718
C-114 1000 uuf X
R. F. SECTION
C-102 5 uuf
C-101 5 uuf
C-103 3-3 uuf
C-104A
C-104B
S-100
IV L-101
I L-100
R-102 330
R-103 330
R-104 330
R-105 330
III L-103
L-102 II
R-111 470
C-105 .001 uf
C-113 1500uuf
S-101
L-104
L-105
L-106
R-110 100
COIL
LO
HI
GND
CAP
C-108
V-102 537B
XQ
R-106 15
C-106 .001 uf
C-107 .001 uf
R-107 1 K
R-108 1 K
V-103 537A (now reds a ~~hot diode~~) - (1920-0009 HP) (6923 or EA52)
C-109 .001 uf
C-110 .001 uf
R-109 15
y
y
per addition required HP-0160-3503 (0.5pf)

105 V
R-211 6.8 MEG.
R-212 6.8 MEG.
S-200 B
R-210 10 K
200 V
R-222 470
R-223 20 K
V-200 538A
R-206 470 K
C-200 .01 M.F.
C-201 .01 M.F.
R-207 2.2 K
R-208 3K
R-209 2.2 K
S-202A
R-213 3K
R-214 3K
R-215 10 K
R-216 7.5 K
R-217 4.4 K
R-218 6.3 K
R-219 37 K
R-220 14-K
S-201C
S-200C
M-200
S-201B
R-203 4 K
R-201 150 K
R-204 200 COARSE ΔQ
R-205 15 FINE ΔQ
R-200 3 K
R-202 3 K
XQ ZERO
Q ZERO
D. V. M.
S-201A
S-200A

POWER SUPPLY
I-300
X
F-300
F-301
S-300
VR-300
T-300
6.0 V .33 A
6.3 V .75A
R-300 75
CR-300
CR-301
C-300 60 uf
C-301 60 uf
C-302 60 uf
L-300 5 hy
200 V
105 V
R-301 2K
V-300 OB 2

Indicates terminals on P-300 & J-300

INPUT
190A 95-130V, 60CPS
190AP 95-130V, 50CPS

FIG. IV-2 SCHEMATIC DIAGRAM Q METER 190-A

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